NASA TECH BRIEF

Ames Research Center

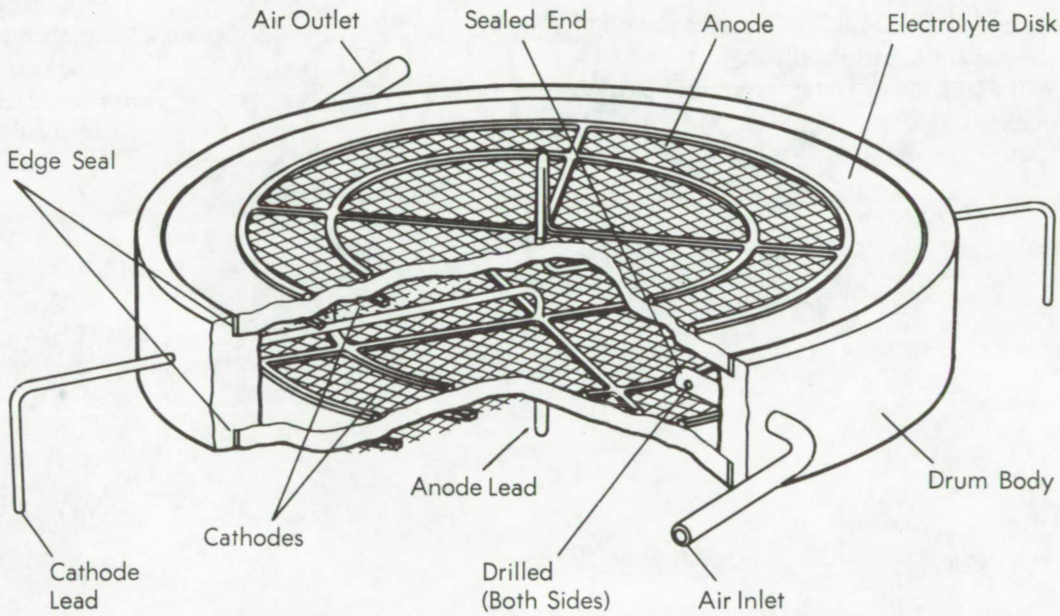
Oxygen Reclamation with Solid Oxide Electrolytes

The problem:

To regenerate oxygen from the metabolic carbon dioxide found in closed-cycle cabin atmospheres.

The solution:

A solid oxide electrolyte operated at an elevated temperature in an electrolysis cell.



How it's done:

The solid oxide electrolyte must be operated at about 870°C in order to maintain Faradaic efficiencies at least of the order of 95%. Operation at high temperatures poses severe problems; considerable power is required to maintain the high temperature and the materials of construction must be able to withstand oxidative attack and to remain integral for long periods of time.

The configuration of a typical electrolytic cell structure for operation at high temperature is shown in the diagram. The drum body supporting two of the cells is made of zirconia partially stabilized by calcium oxide. The electrolyte disk is a solid compaction of 85 mol-percent ZrO_2 and 15 mol-percent CaO. Screens of platinum are attached in intimate contact with each side of the electrolyte disk; a thick film of porous platinum is fired in place on the disk, and then a platinum screen is compression-welded to the film. Alumina tubes are used for inlet and outlet of gas. Typically, the electrolyte cell is operated at

(continued overleaf)

870°C at a flow of 730 ml/min of carbon dioxide and a current of 2 amperes. Operation for at least 91 days has been accomplished, and it is possible to run a cell indefinitely; however, some improvements need to be made on edge-seal materials.

Carbon dioxide in the air within the drum is reduced at the cathodes to carbon monoxide and oxide ions; the oxide ions travel through the solid electrolyte membrane and are discharged at the anode and released as gaseous oxygen into the cabin atmosphere. The carbon monoxide–air mixture which issues from the drum outlet is led to a disproportionation reactor where it is converted to carbon dioxide and solid carbon; the exit gases from the reactor are mixed with cabin air and recycled through the electrolysis drum.

Reference:

Weissbart, J.; Smart, W.; and Wydeven, T.: Oxygen Reclamation from Carbon Dioxide Using a Solid Oxide Electrolyte. Aerospace Medicine, vol. 40, no. 2, p. 136, 1969.

Notes:

1. An electrolyte disk of 93 mol-percent zirconia and 7 mol-percent scandia also is effective.
2. The cells can also convert water vapor into oxygen and hydrogen.
3. A group of cells in series has been operated for over 2000 hours.
4. The following documentation may be obtained from:

    National Technical Information Service
    Springfield, Virginia 22151
    Single document price $3.00
    (or microfiche $0.95)
    Reference:
    NASA CR-73464 (N70-32473), Development of a CO_2-H_2O Solid Electrolyte Electrolysis System.

5. No additional documentation is available. Specific questions, however, may directed to:

    Technology Utilization Officer
    Ames Research Center
    Moffett Field, California 94035
    Reference: B72-10273

Patent status:

No patent action is contemplated by NASA.

Source: Wilson Smart and
Joseph Weissbart of
Applied Electrochemistry, Inc.
under contract to
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